RCA

MOS FET Product Guide

Single-Gate and Dual-Gate Types for Military, Industrial and Commercial Applications

MOS-160C

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RCA MOS Insulated-Gate Field-Effect Transistors

RCA MOS FET Story

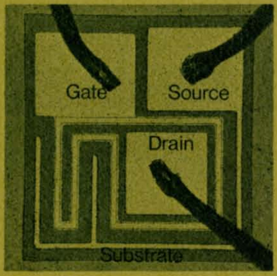
To-72
Metal
Package

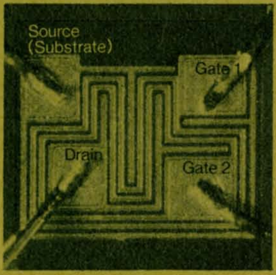
RCA MOS insulated-gate field-effect transistors are N-channel, depletion-type silicon devices, and are available in both single-gate and dual-gate types. Both types offer the advantages of extremely high input resistance, low input capacitance, very low feedback capacitance, high forward transconductance, and low noise at very high frequencies. Because of their insulated-gate construction, these devices have extremely low leakage currents which are relatively insensitive to temperature variations. In addition, their drain currents have a negative temperature coefficient which makes "thermal runaway" virtually impossible.

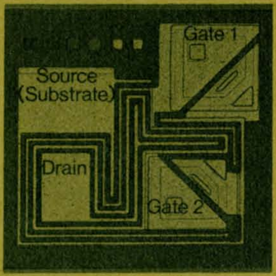
The extremely high input resistance of RCA MOS transistors permits the use of simple, electron-tube-type biasing techniques. It also makes these devices capable of handling relatively large positive and negative input-signal excursions without degradation of input impedance due to diode-current loading. Because of this capability, MOS transistors have considerably greater dynamic ranges than junction-type field-effect transistors and bipolar transistors of comparable ratings, and can provide superior performance in amplifier circuits utilizing automatic gain control. Furthermore, the extremely high input resistances of these devices impose virtually no loading on AGC voltage source.

In addition to the features described above, RCA MOS transistors are notably superior to other solid-state devices in cross-modulation characteristics, and in their relative freedom from spurious responses. These transistors are also characterized by zero offset voltage — a feature which makes them especially desirable for chopper applications.

Applications







RCA Single-Gate MOS Transistors provide outstanding performance in applications requiring extremely high input impedance. They are also capable of providing high power gains at frequencies up to approximately 250 MHz. Typical applications for these devices include rf-amplifier, mixer, and oscillator service in mobile and fixed communications equipment and in home entertainment equipment, and as audio and wide-band amplifiers, variable attenuators, choppers, and current limiters in industrial instrumentation and control equipment. *RCA single-gate MOS transistors also feature a separate terminal permitting connection to the bulk (substrate).*

RCA Dual-Gate MOS Transistors feature a series arrangement of two separate channels, each channel having an independent control gate (see Fig. 2). This arrangement results in substantially lower feedback capacitance, greater gain, remote AGC capability in rf-amplifier applications, substantially better cross-modulation characteristics and lower spurious response than are provided by single-gate types. The availability of two independent control gates also offers unique advantages for chopper, clipper, and gated-amplifier service, and for applications involving the combination of two or more signals, such as mixers, product detectors, color demodulators, and balanced modulators.

RCA Dual-Gate-Protected RF MOS Transistors incorporate back-to-back diodes for each gate within the same silicon MOS FET pellet. The major technical challenge in the development of these new MOS FETS was that gate protection must not significantly degrade the RF performance. Special back-to-back diodes were developed as the answer to this objective.

The back-to-back diodes are diffused directly into the MOS pellet and are electronically connected between each insulated gate and the FET's source; this arrangement permits the device to handle a wide dynamic signal swing and still provide excellent RF performance. The low junction capacitance of the diodes adds little to the total capacitance shunting the gate. Furthermore, the resistive components of these diodes are such that they do not materially affect the overall noise performance of the unit.

The net result is a MOS FET which offers protection against static discharge during handling operations without the need for external shorting mechanisms, protection against in-circuit transients, and is more rugged than any other solid-state amplifier providing comparable performance.

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RCA MOS Insulated-Gate Field-Effect Transistors

Features and Benefits to the Designer

- Extremely high input resistance — imposes virtually no loading on AGC voltage source
- Very low feedback capacitance
- High forward transconductance
- Wide dynamic range — handle positive and negative input-signal excursions without diode-current loading
- Wide AGC range
- Virtually no AGC power required
- Very low gate leakage current — relatively insensitive to temperature variations
- Negative temperature coefficient of drain current — makes "thermal runaway" virtually impossible
- Zero offset voltage — especially desirable for chopper applications
- Bulk (substrate) terminal available on all single-gate types
- Substantially better cross-modulation characteristics and lower spurious response than junction-type FET's and bipolar transistors

RCA Dual-Gate MOS Transistors offer these additional features:

- Extremely low feedback capacitance
- Reduced oscillator feedthrough
- Higher frequency capabilities
- Exceptionally high forward transconductance
- Higher vhf power gain
- No neutralization required
- Increased gain reduction with AGC
- Cross-modulation characteristics actually improve as device approaches cutoff
- Unique advantages for mixer, product-detector, remote gain control, color-demodulator, balanced-modulator, chopper, clipper, and gated-amplifier applications

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Let's Look at the MOS FET

Electrostatic discharges can occur when a device is picked up by its case and the handler's body capacitance is discharged to ground through the series arrangement of the bulk-to-channel and channel-to-gate capacitances of the device. Although insulated-gate MOS Field-Effect Transistors (MOS FETs), like bipolar high-frequency transistors, are susceptible to damage by the electrostatic discharge of energy through the devices, they are currently being extensively used in production by domestic and foreign equipment manufacturers in military, industrial, and consumer applications, with virtually no problems due to damage by electrostatic discharge.

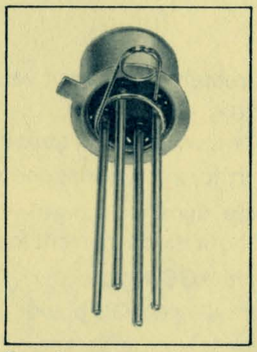
It is evident that care should be exercised in handling and operating all small-geometry devices. By taking several basic precautions and care when working with MOS FET devices, trouble-free service will be assured.

In handling MOS FETs the following precautions should be observed:

1. Prior to assembly into a circuit, all leads should be kept shorted together by either
   A. the use of metal shorting springs attached to the device by the vendor, or
   B. by the use of conductive foam such as "ECCOSORB* LS26" or equivalent.

   NOTE: Polystyrene insulating "SNOW" can acquire high static charges and should not be used.
2. When devices are removed by hand from their carriers, the hand being used should be at ground potential.
3. Tips of soldering irons should be grounded.
4. Devices should never be inserted into or removed from circuits with power on.

*Trade Mark: Emerson & Cuming, Inc.


Drawing shows shorting spring which should not be removed until after device is soldered into circuit.

Please Note:

MOS FETs utilizing diode gate protection do not require the use of a shorting spring.

RCA MOS Insulated-Gate Field-Effect Transistors

Silicon N-Channel Depletion Types

for VHF/UHF, Chopper, Instrumentation and Control Applications in Military, Industrial, and Consumer Equipment

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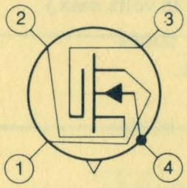
Single-Gate Types

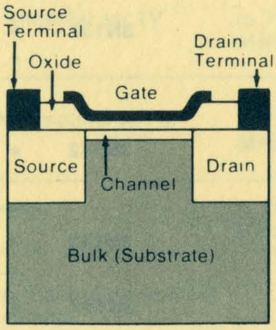
See Footnote — "Single-Gate Types with Integral Gate Protection"

RCA Type

- 3N128
- 3N138
- 3N139
- 3N142
- 3N143
- 3N152
- 3N153
- 3N154
- 40467A
- 40468A
- 40559A



1. Drain
2. Source
3. Gate
4. Bulk (Substrate and Case)

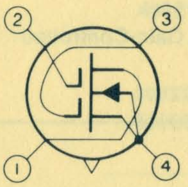


1. Schematic representation of a single-gate MOS field-effect transistor.

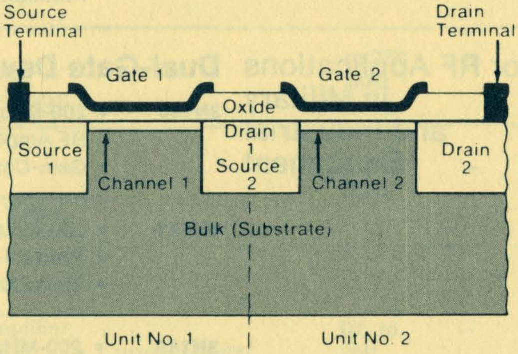
Dual-Gate Types

RCA Type

- 3N140
- 3N141
- 3N159
- 40600
- 40601
- 40602
- 40603
- 40604



1. Drain
2. Gate 2
3. Gate 1
4. Source (Substrate and Case)

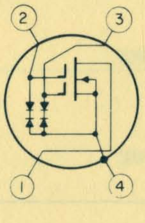


2. Schematic representation of a dual-gate MOS field-effect transistor.

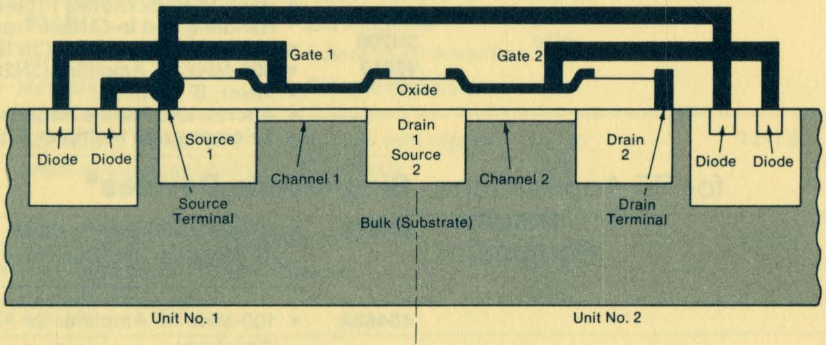
Dual-Gate-Protected Types

RCA Type

- 3N187
- 3N200
- 40673
- 40819
- 40820
- 40821
- 40822
- 40823



1. Drain
2. Gate 2
3. Gate 1
4. Source (Substrate and Case)



3. Schematic representation of a dual-gate-protected MOS field-effect transistor.

Single-gate types with integral gate protection for triode applications can be obtained by a simple modification of the dual-gate-protected devices. This modification is accomplished by connecting Terminal 2 to Terminal 3, as shown in the terminal diagrams on the right. Fig. 1 indicates this connection and Fig. 2 shows the electrical equivalent.

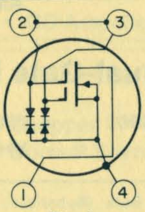


Fig. 1

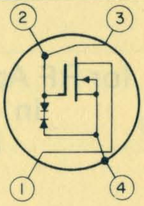


Fig. 2

RCA MOS Insulated-Gate Field-Effect Transistors

Quick Selection Guide

	RCA Type	Applications	Usable Frequency Range	Typical Circuits (Page)	Ratings & Characteristics (Page)
for RF Applications in Military and Industrial Equipment	**Single-Gate Devices■**				
	3N128	• 200-MHz High-Gain, Low-Noise RF Amplifier • IF Amplifier • Oscillator	to 250 MHz	14-15	8-9
	3N139	• Video and AF Amplifier • 200-MHz High-Gain RF Amplifier for use with a higher drain supply voltage (+35 volts max.)	to 250 MHz	—	8-9
	3N142	• 100-MHz High-Gain, Low-Noise, RF Amplifier and Oscillator	to 175 MHz	—	8-9
	3N143	• 200-MHz Mixer	to 250 MHz	—	8-9
	3N152	• 200-MHz Low-Noise Premium-Performance RF Amplifier	to 250 MHz	—	8-9
	3N154	• 200-MHz Low Leakage Premium-Performance RF Amplifier	to 250 MHz	—	8-9
for RF Applications in Military and Industrial Equipment	**Dual-Gate Devices**				
	3N140	• 200-MHz High-Gain, Low-Noise, Gain-Controlled RF Amplifier • Gain-Controlled IF Amplifier	to 300 MHz	15	8-9
	3N141	• 200-MHz Mixer • Product Detector • Modulator	to 300 MHz	15	8-9
	3N159	• 200-MHz High-Gain, Very Low-Noise Gain-Controlled RF Amplifier	to 300 MHz	—	8-9
	Gate-Protected Devices			—	8-9
	3N187 **3N200** **40819**	• Back-to-Back Diodes Protect Each Gate Against Handling and In-Circuit Transients • 300-MHz RF Amplifier (3N187, 40819) • 500-MHz RF Amplifier (3N200) • Mixer, IF Amplifier • Aircraft and Marine Receivers • Telemetry and Multiplex Equipment	to 300 MHz (3N187, 40819) to 500 MHz (3N200)		
for RF Applications in Consumer Equipment	**Single-Gate Devices■**				
	40467A	• 200-MHz General-Purpose RF Amplifier and Oscillator	to 220 MHz	—	8-9
	40468A	• 100-MHz RF Amplifier for FM and AM/FM Receivers	to 125 MHz	16-17	10-11
	40559A	• 100-MHz Mixer or Oscillator Service in FM and AM/FM Receivers	to 125 MHz	16-17	10-11
for RF Applications in Consumer Equipment	**Dual-Gate Devices**				
	40600	• 200-MHz Gain-Controlled RF Amplifier for VHF TV Tuners	to 250 MHz	16	10-11

■ Bulk (Substrate) brought out as a separate terminal lead (connected to case internally).

RCA MOS Insulated-Gate Field-Effect Transistors

Quick Selection Guide

	RCA Type	Applications	Usable Frequency Range	Typical Circuits (Page)	Ratings & Characteristics (Page)
for RF Applications in Consumer Equipment (Continued)	**Dual-Gate Devices (Continued)**				
	40601	• 200-MHz Mixer in VHF TV Tuners	to 250 MHz	—	10-11
	40602	• 44-MHz Gain-Controlled IF Amplifier for TV Receivers	to 75 MHz	17	10-11
	40603	• 100-MHz Gain-Controlled RF Amplifier in FM Receivers	to 150 MHz	—	10-11
	40604	• 100-MHz Mixer in FM Receivers	to 150 MHz	16	10-11
	Gate-Protected Devices	• Back-to-Back Diodes Protect Each Gate Against Handling and In-Circuit Transients			
	40673	• 200-MHz RF Amplifier • Aircraft and Marine Receivers • CATV and MATV Equipment	to 400 MHz	—	10-11
	40820 **40821**	• For VHF-TV Tuners RF Amplifier - Mixer	to 250 MHz	—	10-11
	40822 **40823**	• For FM Tuners RF Amplifier - Mixer	to 150 MHz	—	10-11
for Chopper, Instrumentation, and Control Applications	**Single-Gate Devices■**				
	3N128	• High-Gain DC Amplifier • Variable Attenuator • Current Limiter • High-Impedance Timing Circuits	DC to 250 MHz	—	12-13
	3N138	• Specifically designed for Chopper Service to 60 MHz • DC Amplifier • Servo Amplifier • Operational Amplifier • Multiplexer • Sample and Hold	DC to 250 MHz	17	12-13
	3N139	• DC, Audio, Video, and RF Amplifier with higher drain voltage capability (+35 V max.)	DC to 250 MHz	—	12-13
	3N142	• DC Amplifier • Current Limiter • High-Impedance Timing Circuits • Variable Attenuator	DC to 175 MHz	—	12-13
	3N153	• Chopper and Multiplex Service to 60 MHz • Sample and Hold • Servo Amplifier • Operational Amplifier • Electrometer Amplifier • DC Amplifier	DC to 250 MHz	—	8-9
for Chopper, Instrumentation, and Control Applications	**Dual-Gate Devices**				
	3N140 and 3N141	• DC Amplifier • Chopper • Gated Amplifier • Current Source • Variable Attenuator	DC to 300 MHz	—	12-13

■Bulk (Substrate) brought out as a separate terminal lead (connected to case internally).

RCA MOS Insulated-Gate Field-Effect Transistors

Types for RF Applications in Industrial and Military Equipment

RCA Type	Features	Absolute Maximum Ratings								
		Drain-to-Source Volts V_{DS}		Gate 1-to-Source Volts V_{G1S}		Gate 2-to-Source Volts V_{G2S}		Max. Drain Current I_D mA	Device Dissipation at $T_A = 25°C$ P_T‡ mW	Ambient Temperature T_A °C
		Neg.	Pos.	DC	PeakAC	DC	PeakAC			Operating and Storage
Single-Gate Devices■										
3N128	**200-MHz High-Gain, Low-Noise, RF Amplifier** • Low Feedback Capacitance – $C_{rss} = 0.28$ pF max. • High Forward Transconductance – 7500 μmho typ. • Superior Cross-Modulation Characteristics • High VHF Power Gain – 16dB typ. at 200 MHz • Low VHF Noise Figure – 3.5 dB typ. at 200 MHz	0	+20	+1 to −8	±15	—	—	50	330	−65 to +175
3N139	**Video, AF and RF Amplifier** • Low Input Capacitance – $C_{iss} = 3$ pF typ. • High Gate Voltage – $V_{GS} = \pm 10$V DC • High Forward Transconductance – 600 μmho typ. • High Drain-to-Source Voltage $V_{DS} = +35$V max.	0	+35	±10	±14	—	—	50	330	−65 to +175
3N142	**100-MHz High-Gain, Low-Noise, RF Amplifier and Oscillator** • Power Gain (unneutralized) – 16 dB min. at 100 MHz • High Forward Transconductance – 7500 μmho typ. • Low Noise Figure – 2.5 dB typ. at 100 MHz	0	+20	+1 to −8	±15	—	—	50	330	−65 to +175
3N143	**200-MHz Mixer and Oscillator** • Conversion Power Gain – 13.5 dB typ. at 200/30 MHz	0	+20	+1 to −8	±15	—	—	50	330	−65 to +175
3N152	**200-MHz Premium-Performance RF Amplifier** • Low RF Noise – 2.5 dB typ. at 200 MHz • High Forward Transconductance – 7500 μmho typ.	0	+20	+1 to −8	±15	—	—	50	330	−65 to +175
3N154	**200-MHz Low Leakage Premium-Performance RF Amplifier** • Closely controlled Zero-Bias Drain Current • Low Gate Leakage Current – 50 pA max. • High Forward Transconductance – 7500 μmho typ.	0	+20	+1 to −8	±15	—	—	50	330	−65 to +175
Dual-Gate Devices										
3N140	**200-MHz High-Gain, Low-Noise, Gain-Controlled RF Amplifier** • Power Gain (unneutralized) – 18 dB typ. at 200 MHz • Low Noise Figure – 3.5 dB typ. at 200 MHz • High Forward Transconductance – 10,000 μmho typ. • Useful up to 300 MHz • Excellent AGC Capability from High-Impedance Source	0	+20	+1 to −8	+20 to −8	−8 to 40% of V_{DS}	−8 to +20	50	330	−65 to +175
3N141	**200-MHz Mixer** • 200-MHz Conversion Gain – 17 dB typ. • High Forward Conversion Transcond. – 10,000 μmho typ. • Useful up to 300 MHz • Product Detector	0	+20	+1 to −8	+20 to −8	−8 to 40% of V_{DS}	−8 to +20	50	330	−65 to +175
3N159	**200-MHz High-Gain, Low-Noise, Gain-Controlled RF Amplifier** • Power Gain (unneutralized) – 18 dB typ. at 200 MHz • Low Noise Figure – 3.5 dB max. at 200 MHz • High Forward Transconductance – 10,000 μmho typ. • Useful up to 300 MHz • Excellent AGC Capability from High-Impedance Source	0	+20	+1 to −8	+20 to −8	−8 to 40% of V_{DS}	−8 to +20	50	330	−65 to +175
Dual-Gate Devices with Gates Protected Against Handling and In-Circuit Transients										
3N187	**200-MHz RF Amplifier, Mixer, and IF Amplifier** • Low Gate Leakage Currents – 50 nA max. • High Forward Transconductance – 12,000 μmho typ. • High Unneutralized RF Power Gain – 18 dB typ. at 200 MHz • Low RF Noise Figure – 3.5 dB typ. at 200 MHz	−0.2	+20	+3 to −6	±6	−6 to 30% of V_{DS}	±6	50	330	−65 to +175
3N200	**400-MHz High-Gain RF Amplifier, Mixer, and IF Amplifier** • Low Gate Leakage Currents – 50 nA max. • High Forward Transconductance – 15,000 μmho typ. • High RF Power Gain – 19 dB typ. at 200 MHz 12.5 dB typ. at 400 MHz • Low RF Noise Figure – 3 dB typ. at 200 MHz 4.5 dB typ. at 400 MHz	−0.2	+20	+3 to −6	±6	−6 to 30% of V_{DS}	±6	50	330	−65 to +175
40819	**200-MHz RF Amplifier, Mixer, and IF Amplifiers** • Low Gate Leakage Currents – 50 nA max. • High Forward Transconductance – 12,000 μmho typ. • High RF Power Gain – 18 dB typ. at 200 MHz • Low RF Noise Figure – 3.5 dB typ. at 200 MHz	−0.2	+25	+3 to −6	±6	−6 to 40% of V_{DS}	±6	50	330	−65 to +175

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‡ For derating information, see Technical Bulletins

■ Bulk (Substrate) brought out as a separate terminal lead on each of these devices (connected to case internally).

Electrical Characteristics at $T_A = 25°C$ (With Substrate Connected to Source)

Package (See Page No. 18)	Power Gain (G_{ps}) dB			NF & Power Gain Test Freq. MHz	Noise Figure (NF) dB		Forward Trans-conductance g_{fs} µmho		Gate Leakage Current I_{GSS} nA Max.	Input Cap. C_{iss} pF Typ.	Gate-to-Source Cutoff Volts		Reverse Transfer Capacitance C_{rss} pF		Associated Technical Data		RCA Type
	Min.	Typ.	Max.		Typ.	Max.	Min.	Typ.			Gate 1 V_{G1S} (off) Typ.	Gate 2 V_{G2S} (off) Typ.	Typ.	Max.	Application Note	Device Data Sheet File No.	
TO-72	13.5	16	—	200	3.5	5	5000	7500	0.05	5.5	−3 typ. −8 max.	—	0.16	0.28	AN-3193 AN-3341	309	**3N128**
TO-72	—	—	—	—	—	—	3000	6000	1	3	−6 max.	—	—	—	ST-3703	284	**3N139**
TO-72	16	—	—	100	2.5	4	5000	7500	1	5.5	−3 typ. −8 max.	—	0.16	0.28	ST-3703	286	**3N142**
TO-72	10ϕ	13.5ϕ	—	f_{in} 200 f_{out} 30	—	—	5000	7500	1	5.5	−3 typ. −8 max.	—	0.17	0.3	ST-3703	309	**3N143**
TO-72	14.5	16	—	200	2.5	3.5	5000	7500	1	5.5	−3 typ. −8 max.	—	0.16	0.28	ST-3703	314	**3N152**
TO-72	13.5	16	—	200	3.5	5	5000	7500	0.05	5.5	−3 typ. −8 max.	—	0.16	0.28		335	**3N154**
TO-72	16	18	22	200	3.5	4.5	6000	10,000	1	5.5	−2 typ. −4 max.	−2 typ. −4 max.	0.02	0.03	ST-3703	285	**3N140**
TO-72	—	17ϕ	—	f_{in} 200 f_{out} 30	—	—	6000	10,000	1	5.5	−2 typ. −4 max.	−2 typ. −4 max.	0.02	0.03	ST-3703	285	**3N141**
TO-72	16	18	22	200	2.5	3.5	7000	10,000	1	5.5	−2 typ. −4 max.	−2 typ. −4 max.	0.02	0.03	ST-3703	326	**3N159**
TO-72	16	18	—	200	3.5	4.5	7000	12,000	50	6	−2	−2	0.02	0.03	ST-3703 AN-4018	436	**3N187**
TO-72	10	12.5 19	—	400 200	4.5 3	6	10,000	15,000	50	6	−1	−1	0.02	0.03	ST-3703 AN-4018 AN-4431	437	**3N200**
TO-72	14	18	—	200	3.5	6	—	12,000	50	6	−2	−2	0.02	0.03	ST-3703 AN-4018	463	**40819**

ϕ Conversion gain

◇ Conversion transconductance

RCA MOS Insulated-Gate Field-Effect Transistors For RF Applications in Consumer Equipment

Absolute Maximum Ratings

RCA Type	Features	Drain-to-Source Volts V_{DS}		Gate 1-to-Source Volts V_{G1S}		Gate 2-to-Source Volts V_{G2S}		Max. Drain Current I_D mA	Device Dissipation at $T_A = 25°C$ P_T‡ mW	Ambient Temperature T_A °C
		Neg.	Pos.	DC	Peak AC	DC	Peak AC			Operating and Storage
Single-Gate Devices■										
40467A	**200-MHz General-Purpose RF Amplifier and Oscillator** • High Forward Transconductance – = 7500 μmho typ. • Low Noise Figure – 4.5 dB typ. at 200 MHz • Power Gain – 16 dB typ. at 200 MHz • Low Feedback Capacitance $C_{rss} = 0.28$ pF max.	0	+20	+1 to −8	±15	—	—	50	330	−65 to +175
40468A	**100-MHz RF Amplifier for FM and AM/FM Receivers** • Power Gain (unneutralized) – 14 dB typ. at 100 MHz • Low Noise Figure – 3.5 dB typ. at 100 MHz • High Forward Transconductance – 7500 μmho typ. • Low Feedback Capacitance – $C_{rss} = 0.28$ pF max.	0	+20	+1 to −8	±15	—	—	25	330	−65 to +175
40559A	**100-MHz Oscillator or Mixer in FM and AM/FM Receivers** • 100-MHz Conversion Gain – 21.5 dB typ. • Low Feedback Capacitance – $C_{rss} = 0.3$ pF max.	0	+20	+1 to −8	±15	—	—	25	330	−65 to +175
Dual-Gate Devices										
40600	**200-MHz Gain-Controlled RF Amplifier for VHF TV Tuners** • Power Gain (unneutralized) – 17.5 dB typ. at 200 MHz • Measured Noise Figure – 5 dB max. at 200 MHz • High Forward Transconductance – 10,000 μmho typ. • Low Feedback Capacitance – 0.03 pF max.	0	+20	+1 to −8	+20 to −8	−8 to 40% of V_{DS}	−8 to +20	50	330	−65 to +175
40601	**200-MHz Mixer in VHF TV Tuners** • 200-MHz Conversion Gain – 14 dB typ. • High Forward Conversion Transconductance – 2700 μmho typ.	0	+20	+1 to −8	+20 to −8	−8 to 40% of V_{DS}	−8 to +20	50	330	−65 to +175
40602	**44-MHz Gain-Controlled IF Amplifier for TV Receivers** • High Power Gain (unneutralized) – 28 dB typ. at 44 MHz • High Forward Transconductance – 10,000 μmho typ. • Excellent AGC Capability From High-Impedance Source	0	+20	+1 to −8	+20 to −8	−8 to 40% of V_{DS}	−8 to +20	50	330	−65 to +175
40603	**100-MHz Gain-Controlled RF Amplifier in FM Receivers** • Power Gain (unneutralized) – 24 dB typ. at 100 MHz • Noise Figure – 3 dB typ. at 100 MHz • High Forward Transconductance – 10,000 μmho typ. • Low Feedback Capacitance – 0.03 pF max.	0	+20	+1 to −8	+20 to −8	−8 to 40% of V_{DS}	−8 to +20	50	330	−65 to +175
40604	**100-MHz Mixer in FM Receivers** • Closely Approximates Ideal "Square-Law" Mixer with Consequent Reduction of Spurious Responses • High Forward Transconductance – 10,000 μmho typ. • 100-MHz Conversion Gain – 23 dB typ.	0	+20	+1 to −8	+20 to −8	−8 to 40% of V_{DS}	−8 to +20	50	330	−65 to +175
Dual-Gate Devices with Gates Protected Against Handling and In-Circuit Transients										
40673	**400-MHz RF Amplifier, Mixer and IF Amplifier** • Low Gate Leakage Currents – 50nA max. • High Forward Transconductance – 12,000 μmho typ. • High Unneutralized RF Power Gain – 18 dB typ. at 200 MHz • Low VHF Noise Figure – 3.5 dB typ. at 200 MHz	−0.2	+20	+1 to −6	±6	−6 to 30% of V_{DS}	±6	50	330	−65 to +175
40820	**RF Amplifier for VHF-TV Tuners** • High Forward Transconductance: $g_{fs} = 12{,}000$ μmho typ. • High RF Power Gain: $G_{PS} = 17$ dB typ. at 200 MHz • Low VHF Noise Figure: NF = 3.5 dB typ. at 200 MHz	−0.2	+20	+3 to −6	±6	−6 to 40% of V_{DS}	±6	50	330	−65 to +175
40821	**RF Mixer for VHF-TV Tuners** • High Forward Transconductance: $g_{fs} = 12{,}000$ μmho typ. • 200 MHz Conversion Gain: $G_{PSC} = 11$ dB min.	−0.2	+20	+3 to −4.5	±6	−4.5 to 40% of V_{DS}	±6	50	330	−65 to +175
40822	**RF Amplifier for FM Tuners** • High Forward Transconductance: $g_{fs} = 12{,}000$ μmho typ.	−0.2	+18	+3 to −6	±6	−6 to 40% of V_{DS}	±6	50	330	−65 to +175
40823	**RF Mixer for FM Tuners** • High Forward Transconductance: $g_{fs} = 12{,}000$ μmho typ. • 100 MHz Conversion Gain: $G_{PSC} = 14$ dB min.	−0.2	+18	+3 to −4.5	±6	−4.5 to 40% of V_{DS}	±6	50	330	−65 to +175

■ Bulk (Substrate) brought out as a separate terminal lead (connected to case internally).

‡ For derating information, see Technical Bulletins

Electrical Characteristics at T_A = 25°C (With Substrate Connected to Source)

Package (See Page No. 18)	Power Gain (G_{ps}) dB			N.F. & Power Gain Test Freq. MHz	Noise Figure (N.F.) dB		Forward Trans-conductance g_{fs} µmho		Gate Leakage Current I_{GSS} nA	Input Cap. C_{iss} pF	Gate-to- Source Cutoff Volts		Reverse Transfer Capacitance C_{rss} pF		Associated Technical Data		RCA Type
											Gate 1 V_{G1S} (off)	Gate 2 V_{G2S} (off)			Application Note	Device Data Sheet File No.	
	Min.	Typ.	Max.		Typ.	Max.	Min.	Typ.	Max.	Typ.	Typ.	Typ.	Typ.	Max.			
TO-72	12	16	—	200	3.5	5	4000	7500	1	5.5	−8 max.	—	0.16	0.28	ST-2990A	324	**40467A**
TO-72	14	17	—	100	3.5	5	—	7500	1	5.5	−8 max.	—	0.16	0.28	AN-3453 AN-3535	323	**40468A**
TO-72	—	22φ	—	f_{in} = 100 f_{out} = 10.7	—	—	—	2800◇	1	5.5	−8 max.	—	0.17	0.3	AN-3535	323	**40559A**
TO-72	—	20	—	200	—	5	—	10,000	1	5.5	−3	−3	0.02	0.03	ST-3703	333	**40600**
TO-72	—	14φ	—	200	--	—	—	2700◇	1	5.5	−3	−3	0.02	0.03	ST-3703	333	**40601**
TO-72	—	28	—	44	—	—	—	10,000	1	5.5	−3	−3	0.02	0.03	ST-3703	333	**40602**
TO-72	—	—	24	100	3	4	—	10,000	1	5.5	−3	−3	0.02	0.03	ST-3703	334	**40603**
TO-72	—	23φ	—	f_{in} = 100 f_{out} = 10.7	—	—	—	2,800 ◇	1	5.5	−3	−3	0.02	0.03	ST-3703	334	**40604**
TO-72	14	18	—	200	3.5	6	—	12,000	50	6	−2	−2	0.02	0.03	ST-3703 AN4018	381	**40673**
TO-72	14	17	—	200	4.5	6	—	12,000	50	6	−1	−1	0.02	0.03	ST-3703 AN-4018	464	**40820**
TO-72	11φ	—	—	f_{in} = 200 f_{out} = 44	—	—	—	12,000	50	6	−1	−1	0.02	0.04	ST-3703 AN-4018	464	**40821**
TO-72	19	24	—	100	2	3.5	—	12,000	50	6.5	−2	−2	0.02	0.03	ST-3703 AN-4018	465	**40822**
TO-72	14φ	18φ	—	f_{in} = 100 f_{out} = 10.7	—	—	—	12,000	50	6.5	−2	−2	0.025	0.045	ST-3703 AN-4018	465	**40823**

φ Conversion gain

◇ Conversion transconductance

RCA MOS Insulated-Gate Field-Effect Transistors

For Chopper Applications In Instrumentation and Control Equipment

RCA Type	Features	Absolute Maximum Ratings Drain-to-Source Volts V_{DS}		Gate 1-to-Source Volts V_{G1S}		Gate 2-to-Source Volts V_{G2S}		Max. Drain Current I_D mA	Device Dissipation at $T_A = 25°C$ P_T‡ mW	Ambient Temperature T_A °C
		Neg.	Pos.	DC	Peak AC	DC	Peak AC			Operating and Storage
Single-Gate Devices■										
3N128	**DC Amplifier** • High Input Resistance – $R_{GS} = 10^{14}\,\Omega$ typ. • Low Gate Leakage Current – $I_{GSS} = 50$ pA typ. • Low Feedback Capacitance – $C_{rss} = 0.16$ pF typ. • High Forward Transconductance – 7500 μmho typ. • Bulk (Substrate) Terminal Available.	0	+20	+1 to −8	±15	—	—	50	330	−65 to +175
3N138	**Specifically Designed for Chopper Service to 60 MHz** • Excellent Thermal Stability • Zero Inherent Offset Voltage • Low Leakage Current: 10 pA max. • Low "On" Resistance • High "Off" Resistance • Low Feedback Capacitance – $C_{rss} = 0.18$ pF typ. • Low Input Capacitance – $C_{iss} = 3$ pF typ. • Bulk (Substrate) Terminal Available	0	+35	±10	±14	—	—	50	400	−65 to +175
3N139	**DC, Audio, Video, and RF Amplifier with Higher Drain Voltage Capability (+35 V max.)** • High Input Resistance – $R_{GS} = 10^{14}\,\Omega$ typ. • High Forward Transconductance – 6000 μmho typ. • Low Input Capacitance – $C_{iss} = 3$ pF typ. • High Drain-to-Source Voltage Capability – +35 V max. • Low 1-KHz Noise • Bulk (Substrate) Terminal Available	0	+35	±10	±14	—	—	50	330	−65 to +175
3N142	**DC Amplifier** • Low Gate Leakage Current – $I_{GSS} = 1$ nA max. • Low Feedback Capacitance – $C_{rss} = 0.28$ pF max. • High Forward Transconductance – 7500 μmho typ. • Bulk (Substrate) Terminal Available	0	+20	+1 to −8	±15	—	—	50	330	−65 to +175
3N153	**Chopper and Multiplex Service to 60 MHz** • Excellent Thermal Stability • Zero Inherent Offset Voltage • High Forward Transconductance — 10,000 μmho typ. • Low Leakage Current — 50 pA max. • Low "ON" Resistance • High "OFF" Resistance • Low Input and Feedback Capacitance • Bulk (Substrate) Terminal Available	0	+20	+6 to −8	±14	—	—	50	400	−65 to +175
Dual-Gate Devices										
3N140 and 3N141	**DC Amplifiers** • Low Gate Leakage Current – $I_{GSS} = 1$ nA max. • High Forward Transconductance – (Gate No. 1 to Drain = 10,000 μmho typ. • Excellent Isolation between Gate No. 1 and Gate No. 2 • Extremely Low Feedback Capacitance – $C_{rss} = 0.03$ pF max.	0	+20	+1 to −8	+20 to −8	−8 to 40% of V_{DS}	−8 to +20	50	400	−65 to +175

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* In measurements of Offset Voltage, thermocouple effects and contact potentials in the measurement setup may cause erroneous readings of 1 microvolt or more. These errors may be minimized by the use of solder having a low thermal e.m.f., such as Leeds & Northrup No. 107-1.0.1, or equivalent.

‡ For derating information, see Technical Bulletins

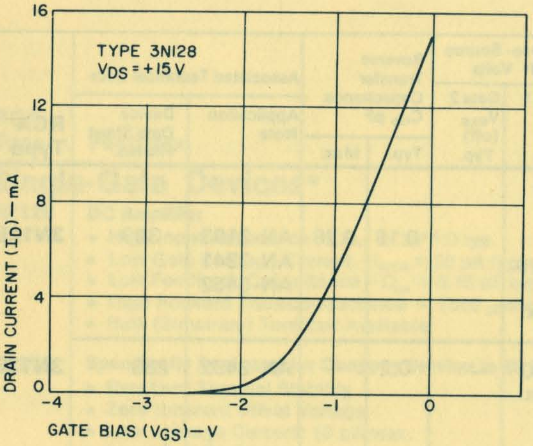
■ Bulk (Substrate) brought out as a separate terminal lead (connected to case internally).

Electrical Characteristics at $T_A = 25°C$ (With Substrate Connected to Source)

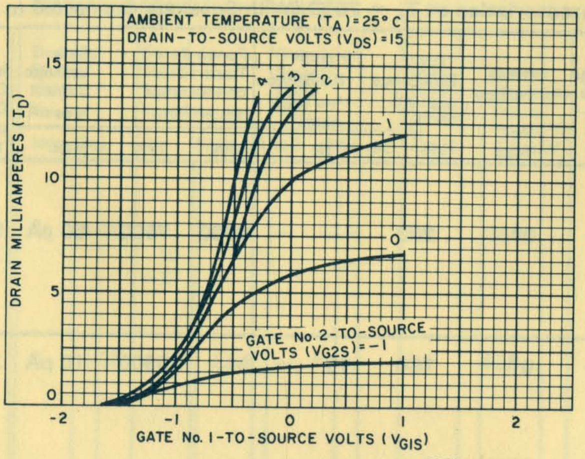
Package (See Page No. 18)	Gate Leakage Resistance r_{GS} ohms Typ.	Offset Voltage Vo* Volts	"ON" Resistance r_{DS} (on) ohms Typ.	"OFF" Resistance r_{DS} (off) ohms Typ.	Forward Trans-conductance g_{fs} µmho		Gate Leakage Current I_{GSS} nA Max.	Input Cap. C_{iss} pF Typ.	Gate-to-Source Cutoff Volts		Reverse Transfer Capacitance C_{rss} pF		Associated Technical Data		RCA Type
					Min.	Typ.			Gate 1 V_{G1S} (off) Typ.	Gate 2 V_{G2S} (off) Typ.	Typ.	Max.	Application Note	Device Data Sheet File No.	
TO-72	10^{14}	0*	200	—	5000	7500	50 pA	5.5	−3 typ. −8 max.	—	0.16	0.28	AN-3193 AN-3341 AN-3452	309	**3N128**
TO-72	10^{14}	0*	180	10^{11}	—	6000	10 pA	3	−10 max.	—	0.2	—	AN-3452	283	**3N138**
TO-72	10^{14}	0*	200	—	3000	6000	1	3	−6 max.	—	0.2	—	AN-3452	284	**3N139**
TO-72	10^{12}	0*	200	—	5000	7500	1	5.5	−3 typ. −8 max.	—	0.16	0.28	AN-3452	286	**3N142**
TO-72	10^{10}	0*	200	10^{10}	—	10,000	50pA	6	−8 max.	—	0.34	0.5		320	**3N153**
TO-72	10^{12}	0*	—	—	6000	10,000	1	5.5	−2 typ. −4 max.	−2 typ. −4 max.	0.02	0.03	AN-3452	285	**3N140 and 3N141**

RCA MOS Insulated-Gate Field-Effect Transistors

Typical Transfer Characteristics

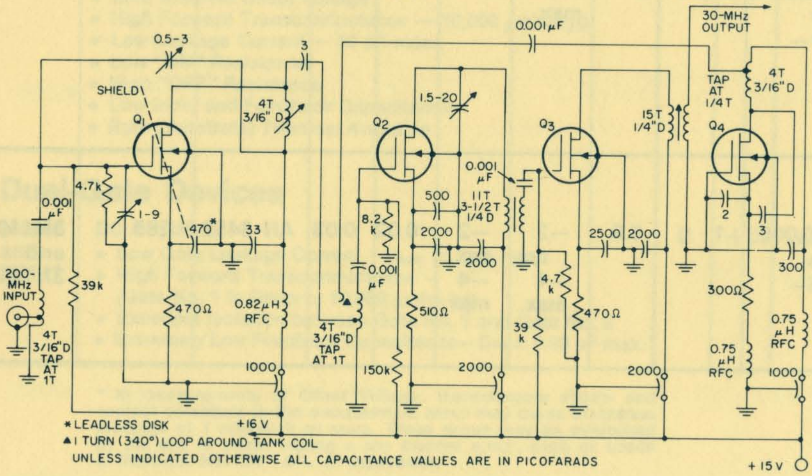


Typical Transfer Characteristic of the RCA-3N128 MOS single-gate field-effect transistor



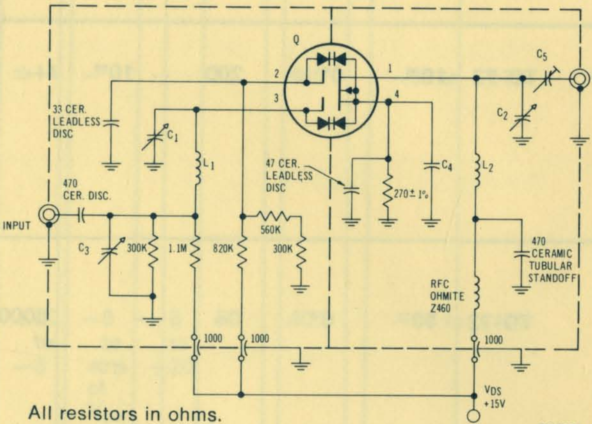
Typical Transfer Characteristics of the RCA-3N140 MOS dual-gate field-effect transistor

Typical Circuits for use in Communications Equipment*



VHF receiver "front end" utilizing Type 3N128 in all stages

Q_1, Q_2, Q_3, Q_4 = Type 3N128
For additional information, refer to RCA Application Note AN3341



All resistors in ohms.
All capacitors in pF.

400 MHz RF Amplifier utilizing type 3N200

C_1, C_2: 1.3-5.4 pF variable air capacitor: Hammerland Mac 5 type or equivalent

C_3: 1.9-13.8 pF variable air capacitor: Hammerland Mac 15 type or equivalent

C_4: Approx. 300 pF-capacitance formed between socket cover & chassis

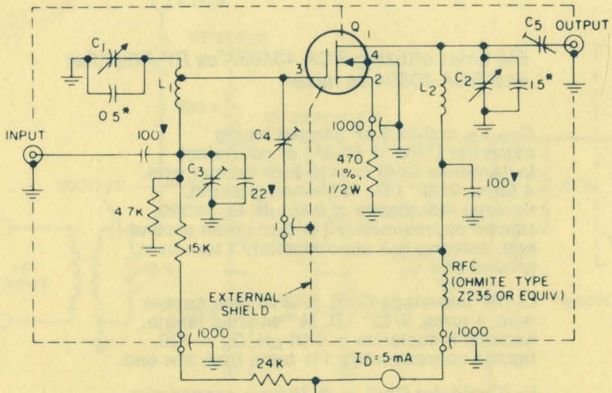
C_5: 0.8-4.5 pF piston type variable air capacitor: Erie 560- or equivalent

L_1, L_2: Inductance to tune circuit

Q: 3N200

✱Numbered publications associated with CIRCUITS are listed on page 18 and are available upon request.

Typical Circuits for use in Communications Equipment* (Continued)



VDD = +15V

ALL RESISTORS IN OHMS AND 1/4 W UNLESS OTHERWISE SPECIFIED

ALL CAPACITORS IN pF

★ TUBULAR CERAMIC

▼ DISC CERAMIC

200-MHz Common-Source Neutralized RF amplifier utilizing Type 3N128

C_1, C_2: 1.5-5 pF variable air capacitor: E. F. Johnson Type 160-102 or equivalent

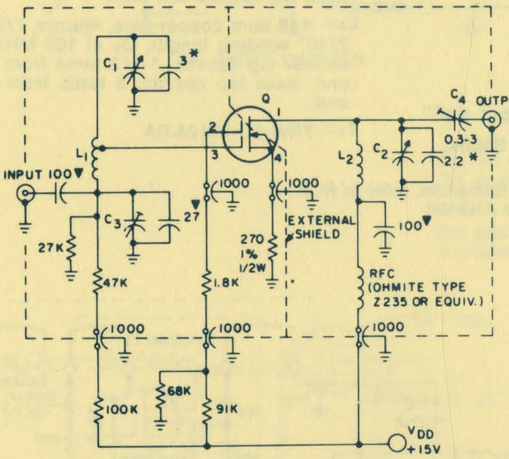
C_3: 1-10 pF piston-type variable air capacitor: JFD Type VAM-010, Johanson Type 4335, or equivalent

C_4, C_5: 0.3-3 pF piston-type variable air capacitor: Roanwell Type MH-13 or equivalent

L_1: 5 turns silver-plated 0.02" thick, 0.07"-0.08" wide copper ribbon. Internal diameter of wiring = 0.25"; winding length approx. 0.65". Tapped at 1-1/2 turns from C_1 end of winding

L_2: Same as L_1 except winding length approx. 0.7"; no tap

Q: 3N128



ALL RESISTORS IN OHMS AND 1/4 W UNLESS OTHERWISE SPECIFIED

★ TUBULAR CERAMIC

▼ DISC CERAMIC

200-MHz RF Amplifier utilizing Type 3N140

Q = Type 3N140

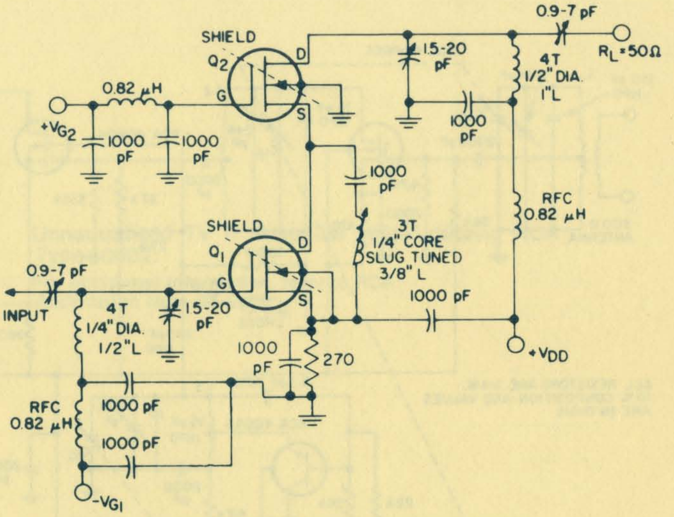
C_1, C_2: 1.5-5 pF variable air capacitor: E. F. Johnson Type 160-102 or equivalent

C_3: 1-10 pF piston-type variable air capacitor: JFD Type VAM-010, Johanson Type 4335, or equivalent

C_4: 0.3-3 pF piston-type variable air capacitor: Roanwell Type MH-13 or equivalent

L_1: 5 turns silver-plated 0.02" thick, 0.07"-0.08" wide copper ribbon. Internal diameter of winding = 0.25"; winding length approx. 0.65". Tapped at 1½ turns from C_1 end of winding

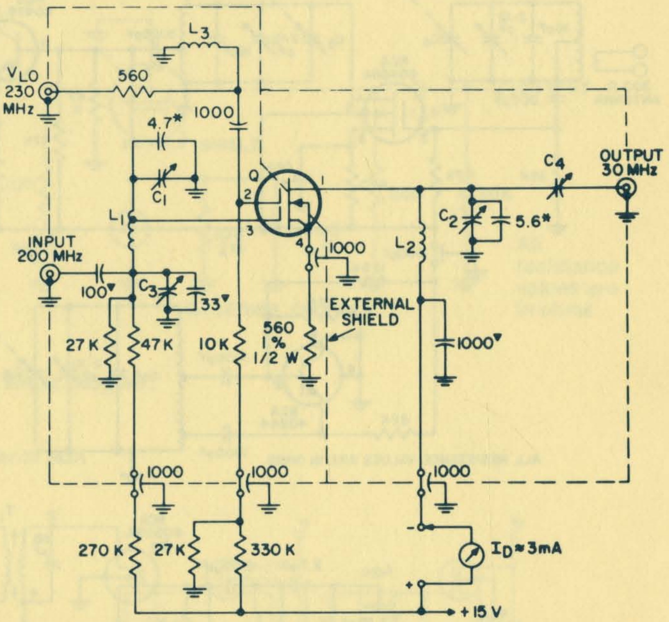
L_2: Same as L_1 except winding length approx. 0.7"; no tap.



200-MHz cascode amplifier utilizing Type 3N128

Q_1 and Q_2 = Type 3N128

For additional information, refer to RCA Application Note AN3193



Mixer Circuit utilizing Type 3N141

Q = 3N141.

C_1, C_2: 1.5-5 pF variable air capacitor: E.F. Johnson Type 160-102 or equivalent.

C_3: 1-10 pF piston-type variable air capacitor: JFD Type VAM-010, Johanson Type 4335, or equivalent.

C_4: 0.3-3 pF piston-type variable air capacitor: Roanwell Type MH-13 or equivalent.

L_1: 5 turns silver-plated 0.02" thick, 0.07"-0.08" wide copper ribbon. Internal diameter of winding = 0.25"; winding length approx. 0.65". Tapped at 1-1/2 turns from C_1 end of winding.

L_2: Ohmite Z-144 RF choke or equivalent.

L_3: J.W. Miller Co. #4580 0.1 μH RF choke or equivalent.

▲ Disc ceramic.

* Tubular ceramic.

All resistors in ohms.

All capacitors in pF.

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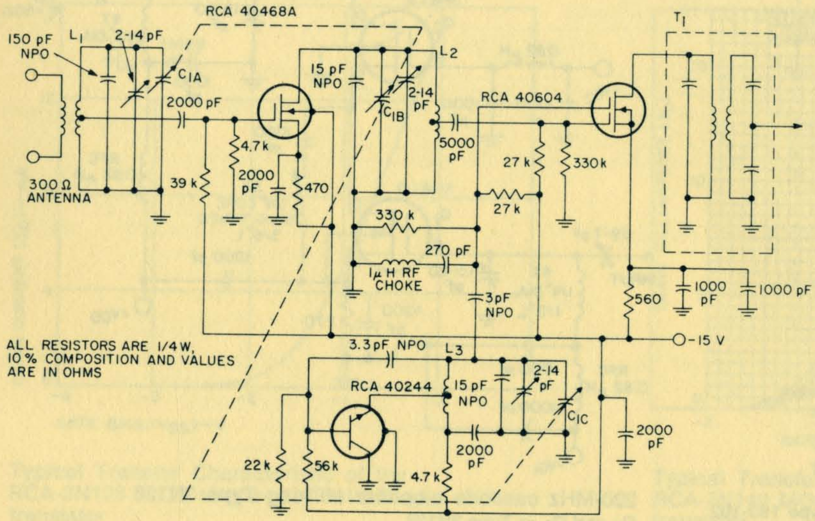
*Numbered publications associated with CIRCUITS are listed on page 18 and are available upon request.

RCA MOS Insulated-Gate Field-Effect Transistors

Typical Circuits for use in Consumer Equipment*



FM tuner utilizing RCA 40468A as RF Amplifier and RCA 40604 as mixer

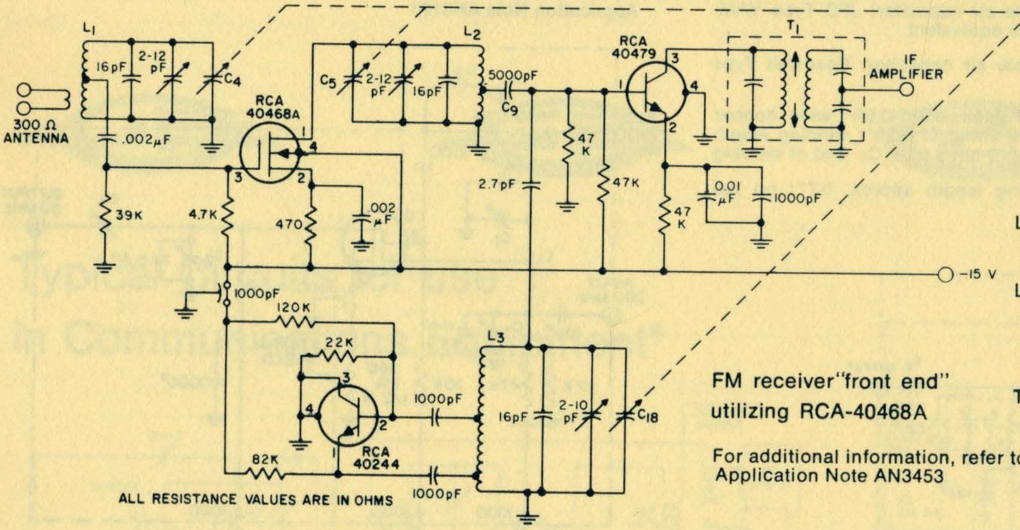
$C_{1(A,B,C)}$ = 6-19.5 pF ganged tuning capacitor (TRW # 57-3A) or equivalent

L_1 (Antenna Coil) = #18 bare copper wire, 4 turns, 9/32" I.D., 3/8" winding length, nominal inductance = 0.86 μH, Q_o = 120, tapped approximately 1¼ turns from ground end, antenna link approximately 1 turn from ground end.

L_2 (RF Interstage Coil) = #18 bare copper wire, 4 turns, 9/32" I.D., 3/8" winding length, nominal inductance = 0.86 μH, Q_o = 120, tapped approximately 1½ turns from low end.

L_3 (Oscillator Coil) = # 18 bare copper wire, 3¼ turns, 9/32" I.D., 5/16" winding length, nominal inductance = 0.062 μH, Q_o = 120, tapped approximately 1 turn from low end.

T_1 (Input transformer to if amplifier) = TRW # 21124-R2 (Design characteristics given in RCA Application Note AN-3466)



C_4, C_5, C_{18} — 5.5-22.5 pF, ganged tuning capacitor.

L_1 = #18 bare copper wire, 4 turns, 1/4" I.D. 7/16" winding length, Q_o at 100 MHz = 130, antenna link approx. 1 turn from ground end, gate tap approx. 1-1/2 turns from ground end.

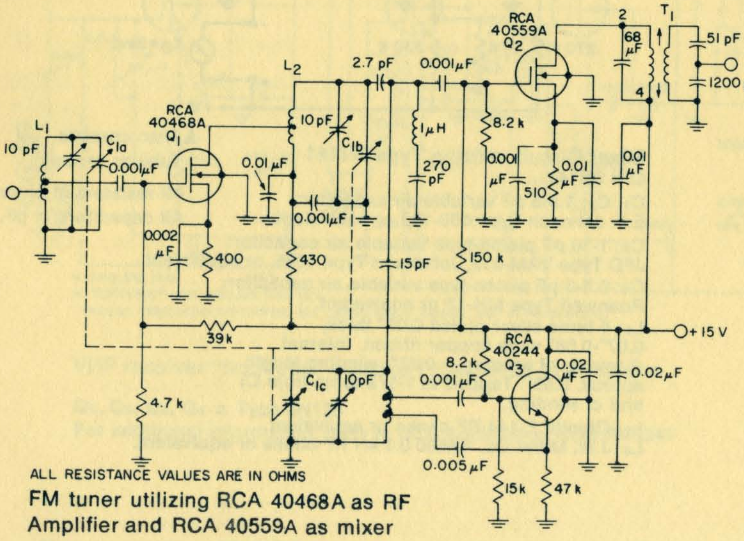
L_2 = #18 bare copper wire, 4 turns, 1/4" I.D., 7/16" winding length, Q_o at 100 MHz = 120, base tap approx. 3/4 turn.

L_3 = #18 bare copper wire, 4 turns, 7/32" I.D., 7/16" winding length, Q_o at 100 MHz = 120, emitter tap approx. 1-1/2 turns from ground end, base tap approx. 2 turns from ground end.

T_1 = TRW-EO-21124-RA

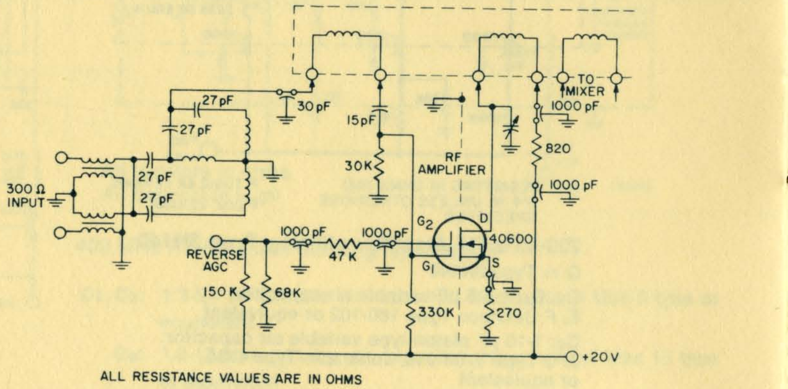
FM receiver "front end" utilizing RCA-40468A

For additional information, refer to RCA Application Note AN3453



ALL RESISTANCE VALUES ARE IN OHMS

FM tuner utilizing RCA 40468A as RF Amplifier and RCA 40559A as mixer



ALL RESISTANCE VALUES ARE IN OHMS

Unneutralized TV tuner RF Amplifier stage utilizing RCA Type 40600

For additional information, refer to RCA Application Note ST-3256

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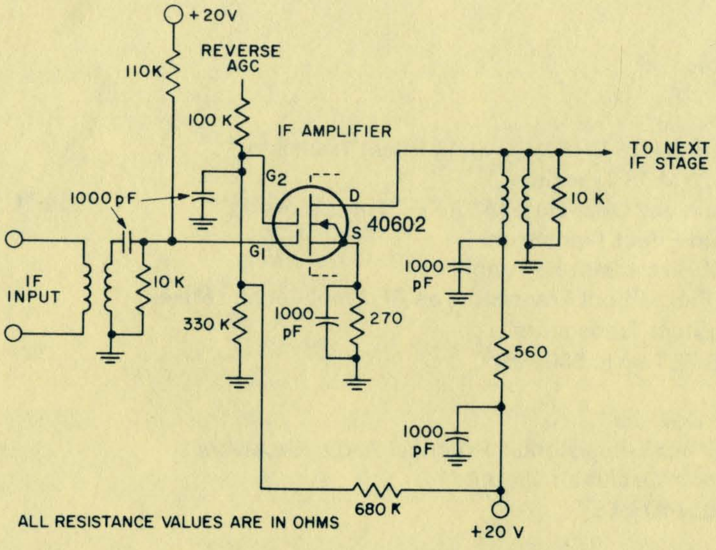
*Numbered publications associated with CIRCUITS are listed on page 18 and are available upon request.

RCA MOS Insulated-Gate Field-Effect Transistors

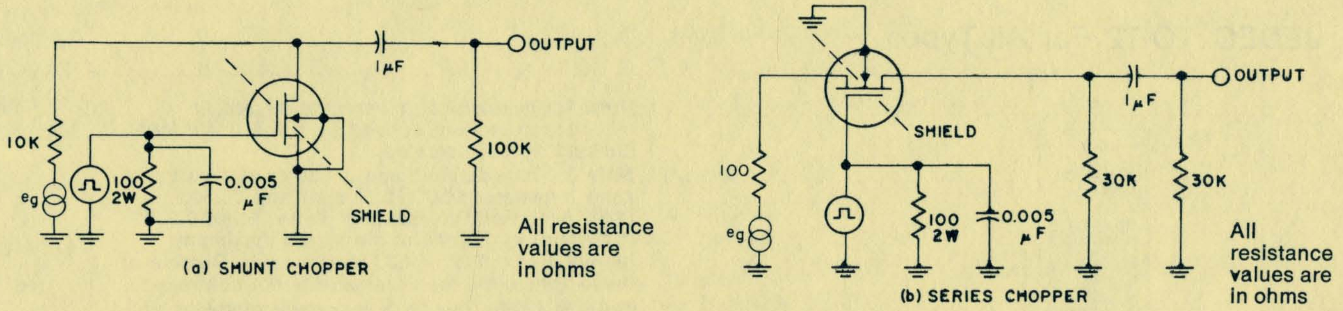
Typical Circuits for use in Consumer Equipment* (Continued)



Unneutralized TV IF Amplifier stage utilizing RCA Type 40602

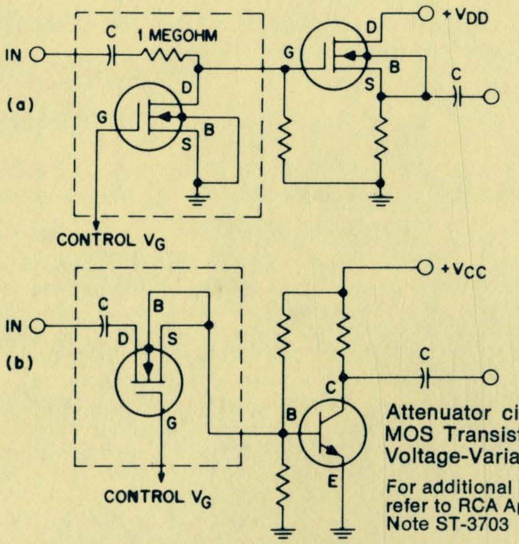
For additional information, refer to RCA Application Note ST-3256

Typical Chopper, Oscillator and other circuits*



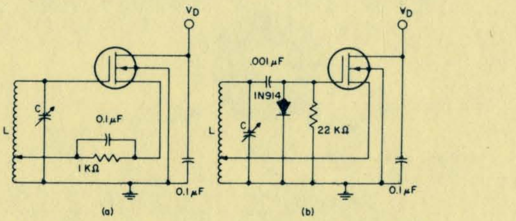
3N138 chopper circuits: (a) shunt chopper; (b) series chopper

For additional information, refer to RCA Application Note AN3452

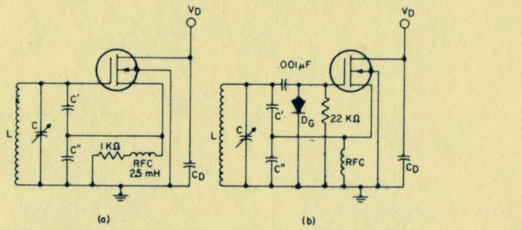


Attenuator circuits utilizing MOS Transistors as Voltage-Variable Resistors.

For additional information, refer to RCA Application Note ST-3703



Hartley oscillator circuits utilizing MOS Transistors



Colpitts oscillator circuits utilizing MOS Transistors

Additional Oscillator Circuits available in RCA Application Note ST-3520

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*Numbered publications associated with CIRCUITS are listed on page 18 and are available upon request.

RCA MOS Insulated-Gate Field-Effect Transistors

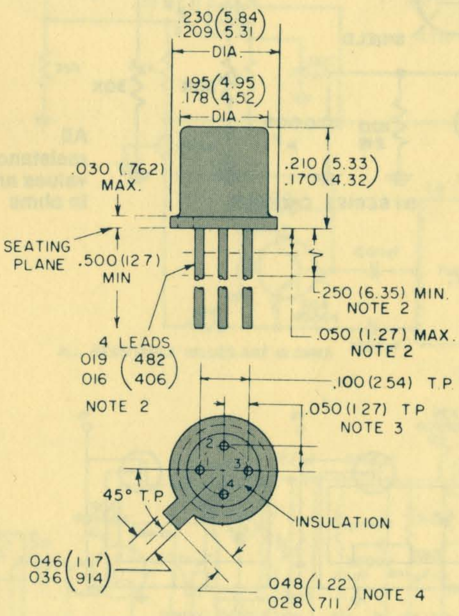
A copy of a Technical Data Bulletin and its Associated Application Note, shown below, are available on request from RCA, Commercial Engineering, Harrison, N.J. 07029. To expedite receipt of the requested data, please refer to the indicated Technical Bulletin File No. or Application Note No.

Application Notes

AN3193	"Application Considerations for the RCA-3N128 VHF MOS Field-Effect Transistor"
AN3341	"VHF Mixer Design Using the RCA-3N128 MOS Transistor"
AN3435	"Cross-Modulation Effects in Single-Gate and Dual-Gate MOS FET Transistors"
AN3452	"Chopper Circuits Using RCA MOS Field-Effect Transistors"
AN3453	"An FM Tuner Using an RCA-40468 MOS-Transistor RF Amplifier"
AN3535	"An FM Tuner Using Single-Gate MOS Field-Effect Transistors as RF Amplifier and Mixer"
AN4018	"Design of Gate-Protected MOS Field-Effect Transistors"
AN4431	"RF Applications of the Dual-Gate MOS FET up to 500 MHz"
ST3703	"MOS Field-Effect Transistors"
ST3233	"Small-Signal RF Amplification of MOS Devices"
ST3486	"Application of Dual-Gate MOS Field-Effect Transistors in Practical Radio Receivers"
ST3520	"Insulated-Gate Field-Effect Transistors in Oscillator Circuits"
ST3529	"Understanding and Using the Dual-Gate MOS FET"
ST4125	"MOS FET Biasing Techniques"

Dimensional Outline

JEDEC TO-72 For All Types



Note 1: *Dimensions in parentheses are in millimeters and are derived from the basic inch dimensions as indicated.*

Note 2: The specified lead diameter applies in the zone between 0.050" (1.27 mm) and 0.250" (6.35 mm) from the seating plane. From 0.250" (6.35 mm) to the end of the lead a maximum diameter of 0.021" (0.533 mm) is held. Outside of these zones, the lead diameter is not controlled.

Note 3: Leads having a maximum diameter of 0.019" (0.482 mm) at a gauging plane of 0.054" (1.372 mm) + 0.001" (0.025 mm) — 0.000" (0.000 mm) below seating plane shall be within 0.007" (0.177 mm) of their true position relative to a maximum width of tab.

Note 4: Measured from actual maximum diameter.

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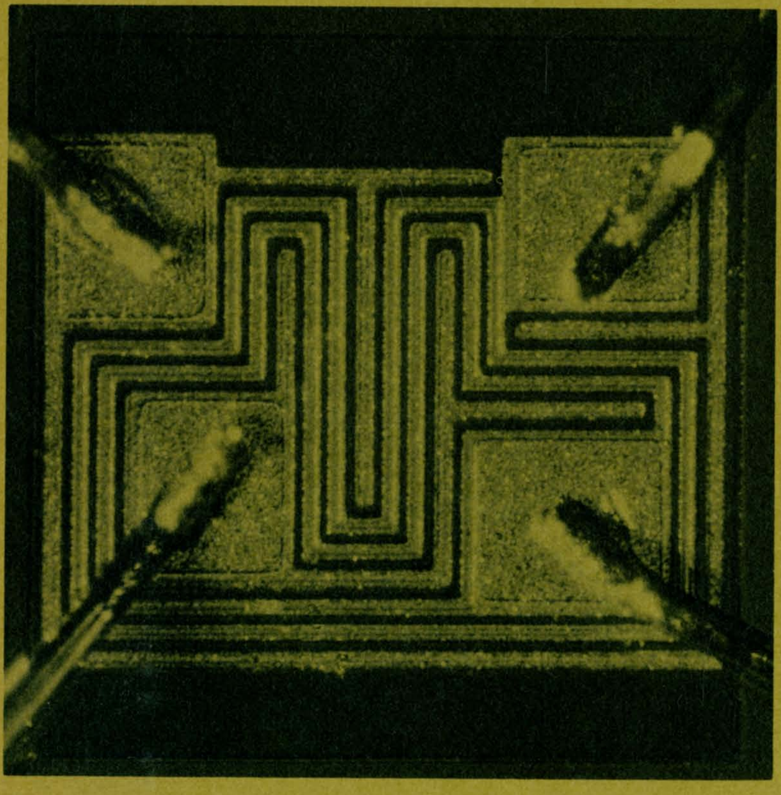
Single-Gate and Dual-Gate Types for Military, Industrial and Commercial Applications



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